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Yazawa, S.; Samuel, G.G.; Hagos, F.; Kruseman, G.; Linderhof, V.G.M.; Yohannes, M.; Mulugeta, A.; Abreha, Z.

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Small scale water harvesting in Northern Ethiopia: Can it alleviate household poverty?

Overview

Ethiopia is one of the most drought prone countries in the world. Yet much of Ethiopia's economy depends upon adequate and reliable rainfall for agricultural production. Over the years scanty and erratic rainfall has led to significant crop losses, and in some cases total crop failure. This means food crises and famine. Millions of Ethiopians have been affected. Half the population is chronically poor and nearly one quarter of children born do not reach the age of five. Higher temperatures due to climate change only exacerbate the pressure on Ethiopia's already fragile ecosystems.

In order to fight poverty and famine by providing food security, effective development of water resources is vital for Ethiopia. Water harvesting is one strategy used to increase agricultural productivity and household income. It is an important tool for mitigating the adverse effects of climate change. Historically, water harvesting in Ethiopia dates back to 560 BC, where rainwater was harvested and stored in ponds for agricultural and water supply purposes. These days, the construction of ponds and wells aims to make water available to irrigate and produce higher value crops, as well as to provide water for livestock and household use. However, there has been limited effort to systematically assess the impact of these structures on household welfare. Can access to ponds and wells alleviate household poverty?

This study applies advanced econometric techniques to assess the impact of water harvesting on household welfare. The results show that access to either ponds or wells is not reflected in higher levels of welfare. Ponds and wells are not exploited to their full potential because most of the structures are recently constructed. One task for policy makers is to come up with technologies to improve water use efficiency. Other results show that labour work by men and the holding of livestock reduces poverty. Therefore a good poverty reduction strategy for households might be a mix of farming, labour work and livestock holding.



Issues facing policy-makers:

- Are households with access to ponds and wells better off in terms of household welfare?
- If not, why not? Can ponds and wells be used more efficiently?
- Are there other determinants of rural household poverty that need to be addressed?
- What would be the most appropriate household strategy for poverty alleviation in Tigray?



Study Area

Ethiopia is located in the Horn of Africa and is bordered by Eritrea, Djibouti, Somalia, Kenya and Sudan. With a population of 75 million people it is the second most populous country in Africa. Ethiopia is divided into nine administrative regions, the northernmost of which is Tigray. About 4 million people live here, most of whom are farmers. Tigray has a semi-arid climate with scanty and erratic rainfall that remains insufficient for crop production. Since 2003, household water harvesting schemes have been expanding as an integral part of the Tigray regional food security and extension programmes, aimed at breaking the cycle of famine. About 30,000 ponds have been built so far, with more than 200,000 planned over the next couple of years in the more drought prone areas of Tigray. The study draws on data collected from 650 households within thirteen tabias (villages). The tabias were selected on the basis of i) differences in agro-ecology (lowland, middle altitude and highland); ii) presence of ponds and water wells; iii) distance to market and iv) the availability of baseline information.



The approach

Economists analyze agricultural household behaviour by using the agricultural household model. This model assumes that an agricultural household, such as those in Tigray, engages in farming and consumption activities at the same time using scarce resources (e.g. money, labour, tools, land) in order to attain their goals and aspirations. Environmental constraints (e.g. climate, soil fertility) and socio-economic constraints (e.g. household income) are also taken into account. A large-scale survey of 650 farm households was conducted in Tigray to collect information regarding household characteristics, demographics, household assets and village level factors. Data was also collected from households with and without access to ponds and wells in order to assess the impacts of water harvesting on household welfare, while controlling for other socio-economic features. With matching methods and econometric analysis, the levels of



welfare for households with and without access to ponds or wells were compared. Additionally, a simple cost-benefit analysis of the construction and maintenance of ponds and wells was carried out. This helps us to calculate how financially viable ponds and wells are for households in Tigray.

Key findings

1. *There are no significant effects on household welfare from owning a pond or a well.*

The results show that there is no statistically significant difference in welfare standing between households with and without access to ponds and wells. Although this study does not fully explore the reasons behind these unexpected results, ponds and wells are currently not being exploited to their fullest potential. On the one hand, access to ponds and wells is still limited for many households, and on the other hand, there may also be a period of acclimatization needed for households to learn how to harvest water efficiently. As a result, there has been little impact on household poverty alleviation.

2. *However, the economic return of wells is far superior to that of ponds.*

Three criteria were used to financially evaluate the benefits of water-harvesting (internal rate of return, net present value and benefit-cost ratio). Basically, if the benefits are greater than the costs, then the project is worthwhile. If they are less, then it isn't. Over a ten-year planning period with a crop value of 3 Birr per kg, both ponds and wells have positive economic returns judged by all three criteria (see Table 1).

	Ponds	Wells
Revenue	8.931	14.674
Construction cost	4.295	2.182
Maintenance cost	655	524
Production cost	2.450	2.301
Input cost		269
Output	2.977	6.048
Total cost	7.133	4.751
Net benefit	1.798	10.847

Amounts (Birr) in Net Present value with $r = 10\%$

Table 1: Cost and benefit analysis of ponds / wells

However, the economic return of wells is much greater than that of ponds. Ponds face higher costs for construction and maintenance and lower revenues compared to wells. Wells store water longer than ponds do enabling farmers to grow crops (usually high value crops) during the dry season. Ponds are promoted and used primarily for supplementary irrigation.



We also calculated the benefits of water harvesting over a five year planning period and with a drop in crop value to 2 Birr per kg. This is a realistic scenario since the planning horizon of poor farmers is short and prices of vegetables and fruits will fall with increases in production. While the economic returns of wells are still positive, the returns for ponds are negative. There are various factors besides the design and the quality of construction that contribute to the success or failure of ponds and wells. These include the discount rate, planning horizon of the users, prices of products and costs of production. Much has to go well, especially if ponds are to give economically attractive returns.

3. *There are key household characteristics which determine poverty in Tigray.*

This study also explores the factors that help to explain household poverty. Poor households show one or more of the following characteristics: they are female-headed; have a higher number of dependents per productive family member consumer-worker ratio (i.e. more consumption per worker); have more female than male adult labourers; are located in mid- and lowland agro-ecologies and are further away from the nearest health centre. Since highly variable rainfall makes agricultural production uncertain, this uncertainty is

also a key factor in determining household poverty. In comparison, wealthier households have a higher number of adult male labourers than female labourers; own livestock such as oxen; tend to be male-headed households and are located in the highlands.



Solutions for policy makers

Since 2003, household water harvesting schemes have been expanding as an integral part of the Tigray regional food security and extension programmes, aimed at breaking the cycle of famine. Currently, there are no significant effects

on household welfare from owning a pond or a well. The challenge for policy makers is twofold: Firstly, to implement strategies which help households to optimally utilise ponds and wells and secondly, to implement policies which target the determinants of household poverty in Tigray.

From our research we advise the following solutions:

- The promotion of ponds at a large scale should be approached with caution as they may pose more cost than benefits to the households or the society at large.
- Measures such as the promotion of household drip kits and crops with high returns and the use of shedding to reduce evaporation, should be introduced to increase the efficiency of water use and minimize water loss.
- The creation of employment opportunities and special support programs for women could contribute to poverty alleviation.
- Policy has to support livestock-poor households to have access to such assets, for instance through the implementation of credit programs.
- The provision of social services such as health centres plays a critical role in human health, and hence, on poverty reduction.
- The implementation of water harvesting structures has to be maintained or even strengthened in order to minimize the uncertainties posed by unreliable rainfall.

PREM: In brief

The Poverty Reduction and Environmental Management (PREM) programme aims to deepen and broaden the exposure of economic researchers and policy advisors in Africa and Asia to the theory and methods of natural resource management and environmental economics. It is anticipated that this will encourage policy changes that address both poverty reduction and sustainable environmental management.

This policy brief is based on the PREM project 'Water-harvesting for poverty reduction and sustainable resource use: Adaptation strategies to climatic change in Tigray region, Ethiopia'
By: Eyasu Yazawa, Girmay G/Samuel, Fitsum Hagos, Gideon Kruseman, Vincent Linderhof, Mekonen Yohannes, Afeworki Mulugeta & Zenebe Abreha

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For further information about PREM, contact:

Pieter van Beukering
Institute for Environmental Studies (IVM)
Vrije Universiteit
De Boelelaan 1087
1081HV Amsterdam The Netherlands
Tel. +31(20)5989555/Fax. +31(20)5989553

beukering@ivm.vu.nl
www.prem-online.org - www.vu.nl/ivm